Appln No. 10/037,414
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Amendments to the Specification:

On page 3, lines 14-29, please amend as follows:

The technique of Nakamata and Grimm may be employed for critical bonding applications providing the thermal energy delivered by the welding process can be limited. A very narrow bond line is a practical method of achieving hermeticity at limited power levels. Nakamata's sealing method can provide a narrow bond line because of the non-diverging nature of a laser beam (i.e. a laser with a wavelength of 808 ± 10 nm has a 0.8 mm beam diameter). Grimm, however, provides a wider beam by using a lamp and reflector system with the weld at the focal length of the lamp/reflector system. In both of these approaches, either the optical source or the work piece (or both) must move in the appropriate trajectory to accomplish the bond at the required location. The correct amount of compression force for the requisite amount of time must follow the beam, and this requires complicated, automated tooling or robotic systems. In this approach, furthermore, there is an inherent discontinuity at the starting point and at the ending point of the weld, which may effect the quality of the product. Goldstein and Tolley disclosed a TTIR method using a photon reflecting mask in U.S. Patent Application Number **[[**60/116/575**]]** 60/116,575 Filed January 21, 1999 and 09/488,887 Filed January 21, 2000.

At page 6, line 19 to page 7, line 12, please amend as follows:

FIGS.1a and 1b are cross-sectional views showing an apparatus designed with the principles described in the present invention;

FIGS. 2a and 2b are cross-sectional views showing a second apparatus designed with the principles described in the present invention;

FIG. 3 is a cross-sectional view showing a radiant source bonding two components of the work piece in accordance to the basic embodiment of the process according to the present invention;

FIG. 3a is a detailed view of an embodiment of the bottom component of Fig. 3 and FIG. 3b is a detailed view of an alternative embodiment of a bottom component.

FIGS. 4a and 4b are cross-sectional views of two light pipes designed to conform to the principles established in the present invention and FIGS. 4c and 4d are end views of the respective masked ends of the light pipes of FIGS. 4a and 4b;

FIGS. 5a, 5c, 5e and 5g **[[**through 5d**]]** are cross-sectional views showing various cooling schemes for the light pipes and FIGS. 5b, 5d, 5f and 5h are end views of the respective cooling schemes;

FIGS. 6a and 6b are cross-sectional views showing a third apparatus designed with the principles described in the present invention;

FIGS. 7a through 7h are cross-sectional views showing a step-by-step welding process of a fourth apparatus designed with the principles described in the present invention;

FIG. 8 is a top view of a fully automated conveyor system where plastic components are processed continuously under an apparatus similar to those described on figures 1, 2, 6, and 7;

FIG. 9 is a cross-sectional view of a welding apparatus used on a system such as the one described in Figure 8.

At page 7, line 15- to page 8, line 11, please amend as follows:

[[Figure 1a shows]] Figures 1a and 1b show an embodiment of a photon welder, which comprises several features of the current invention. A component 110 made with highly absorptive radiation characteristics [[110]], is placed in intimate contact with another component 109 that allows transmission of radiant energy [[109]], into a nest or base 114 with means to provide a force 111 (Figure 1b), which could be provided by springs 117, or a linear actuator or other device that will produce the same result. A movable plate 115 provided with bushings 116 is pushed upward by a pneumatic piston 119 as Figure [[1b]] 1a shows. The plate carries the nest 114 upward in a linear motion and maintains alignment to a light pipe 105 or a thin mask composed of a transparent material such as silicon dioxide and a reflective material placed on all locations except where the welding of the components is desired. The plate moves along shafts 124 extending from a base 121 to aid on the alignment of the components to be welded and the light pipe or thin mask. When in contact with the shaped and masked end of the light pipe 105, the movable plate 115 activates a contact switch or a proximity sensor (not shown) which turns on the light source 101 supported by a plate 122. [[The]] An elliptical reflector 102, directs light produced by the source towards the light pipe 105. Supported by a retaining plate 123, a [[A]] fan 112 provides cooling 113 to the reflector 102 continuously. As shown in

Figure 1b, radiation [[Radiation]] 104, impinging on the entrance of the light pipe 105, travels through the pipe 106, through the exit of it, and then through the first component 109 that comprises part of the assembly to be bonded. Finally, the radiation is absorbed by the second component 110 of the assembly causing it to melt and transfer energy upward to the top component by convection and conduction, which melts a portion of the top component. The melted area cools to a bond during a dwell time of 1 to 4 seconds. Upon completion of the weld, a timed controller (not shown), retracts the movable plate 115 to its original position as shown on Figure 1a. To prevent over-welding or the melting of plastic components (distorting the exterior surfaces), the temperature of the light pipe is controlled by a temperature sensor 130, which activates a fan or blower 118 providing cooling air to the exit end of the light pipe.

On page 8, line 12 to page 9, line 2, please amend as follows:

[[Figure 2a shows]] Figures 2a and 2b show another embodiment of a welding device designed with the principles established by the invention. On this version, the linear motion is provided to a [[the]] light pipe 205, a [[the]] light source 201, a reflector 202, and [[the]] a fan 212, by a piston 219 located on a retaining plate [[222 provided with bearings 216]] 226. A movable plate 223 [[also]] provided with bearings 216 slides downwards on shafts 224, extending from a base 221, simultaneously with the [[the retaining plate 222 and]] a movable plate [[223]] 222. When the plates slide downward

(Figure 2b), the light pipe 205 with its shaped and masked end comes in contact with the components to be bonded 209 and 210 in a nest 214 with means to provide a force 211 (Figure 2b) with springs 217 (Figure 2a). As the plates 222 and 223 move downward, a contact switch or a proximity sensor (not shown) activate the light source 201. Light produced by the source 201 is directed by the elliptical reflector 202, towards the light pipe 205. **[[A]]** The fan 212 provides cooling 213 to the reflector 202 continuously. Radiation 204 (Figure 2b) impinging on the entrance of the light pipe 205 travels through the pipe 206 (Figure 2b) the exit of it, and then through the first component 209 that comprises the assembly to be bonded. Finally the radiation is absorbed by the second component 210 of the assembly causing it to melt and thus bond with the first component of the assembly. Upon completion of the weld, a timed controller (not shown), retracts the movable plate assembly (222 / 223 and connecting shafts 225), to its original position as shown on Figure 2a. To prevent over-welding or the melting of plastic components, the temperature of the light pipe is controlled by a temperature sensor 230, which activates a fan or blower 218 providing cooling air to the exit end of the light pipe.

On page 9, line 3 to page 10, line 28, please amend as follows:

[[Figure 3 illustrates**]]** Figures 3 through 3b illustrate a third embodiment of the invention. A quartz-halogen tungsten lamp 301 (typically 410 to 1000 watts in machines, although not limited to these powers) includes an elliptical reflector 302

coated with highly reflective material 303 (aluminum or gold coated onto elliptical metal reflector). Photons 304 reflected by the walls of the metal reflector is directed towards the entrance of a light pipe 305 made of fused silica (quartz). Photons 304 produced by the light source 301 travel the length of the entire light pipe 306. An exit is provided for the photons 304 at predetermined areas at the end of the light pipe 305. A highly reflective material **[[**308**]]** 353, acting as a mask 308, placed at the end of the light pipe prevents photons from exiting through unwanted areas.

With **[[**the**]]** a top plastic component 309 in intimate contact with **[[**the**]]** a bottom plastic component (e.g. in the form of an L-shaped recess 310a (Figure 3a) or a butt joint 310b (Figure 3b) and held clamped between the light pipe and a base (not shown) a force 311 is applied **[[**311**]]**, the light source 301 is energized, the photons 304, reflected by the reflector's surface 303, are transmitted by the light pipe 305 through an unmasked area 336 and through the material of the top component 309, and finally absorbed by the material of the bottom component 310. Because both the top plastic component 309 and the bottom plastic component 310 are in intimate thermal contact, when the bottom photon absorbing plastic component 310 melts, the top transparent plastic component 309 melts too as the heat is transmitted to it by conduction and convection.

Figures 4a and 4b depict two basic light pipe configurations where a point of entry is provided for the light 427, a path 405 for the light is provided **[[**405**]]**, and a masked area 408 to prevent radiation from striking unwanted sections is

placed at the point of exit of the light pipe. The masked area of the light pipe is coated with a highly reflective material such as gold or aluminum. The weld location 428 is determined by a small area on the periphery of the quartz light pipe, which is not coated with reflective material [[428]] (Figures 4c and 4d).

Figures 5a through [[5d]] 5h describe several embodiments of this invention, which provide thermal management to [[the]] an end of [[the]] a light pipe 505 because the light pipe absorbs heat during each weld. These embodiments include [[(Figure 5a)]] (Figures 5a and 5b) the use of heat dissipaters or heat sinks 531 provided with radial fins 532; [[Figure 5b shows]] Figures 5c and 5d show a water cooled heat exchanger 533, wrapped around the light pipe with water 534, forced through it to maintain the temperature of the light pipe at appropriate levels; heat pipes [[(Figure 5c)]] 535 (Figures 5e and 5f) can be utilized [[535]] along with a fan 537 to help remove the heat from the light pipe 536, thus cooling the light pipe; and [[Figure 5d shows]] Figure 5g and 5h show an annulus 538, where compressed air is channeled through openings to cool the light pipe 539.

Figures 6a and 6b depict a manual welding device based on the principles established by the invention. A component 610 made with high absorptive radiation characteristics [[610]], is placed in intimate contact with another component 609 that allows transmission of radiant energy [[609]] into a nest [[or base]] 614 with means to provide a force 611 (Figure 6b) with springs 617 or other device that will produce the same result. A movable plate 615, provided with bushings 616, is pushed upwards

by a cam 641 mounted on a shaft 640 turned manually. As Figure 6b shows, the plate carries along <u>the</u> **[[**a**]]** nest 614 upward in a linear motion and maintains alignment to the light pipe by shafts 624 <u>extending from a base 621</u>. When in contact with <u>a</u> **[[**the**]]** shaped and masked end of <u>a</u> **[[**the**]]** light pipe 605, the movable plate 615, activates a contact switch or a proximity sensor (not shown) which turns on <u>a</u> **[[**the**]]** light source 601. Light produced by the source is directed by <u>an</u> **[[**the**]]** elliptical reflector 602, towards the light pipe 605. A fan 612**[**,**]** provides cooling 613 to the reflector 602 continuously. Radiation 604 <u>(Figure 6b)</u>, impinging on the entrance of the light pipe 605, travels 606 through the pipe, the exit of it, and then through the first component 609 that comprises the assembly to be bonded. Finally the radiation is absorbed by the second component 610 of the assembly causing it to melt and thus bond with the first component of the assembly. Upon completion of the weld, the operator moves the crank (not shown) in the opposite direction and allows the movable plate 615, to retract to its original position as shown in Figure 6a. In order to prevent over-welding or the melting of the plastic components, a temperature sensor 630 initiates cooling. A small fan 618 <u>(Figure 6a)</u> provides cooling air to the exit end of the light pipe.

On page 11, lines 1-29, please amend as follows:

Figures 7a through 7h present another welding apparatus where <u>a</u> **[[**the**]]** light pipe 705 remains in a fixed position, while a linear actuator 745 <u>(Figure 7d)</u>, provides a linear

motion to a nest 714, held in a drawer-like fixture 742. The figures depict the step-by-step process required to complete the welding of two components in this embodiment. Figure 7a presents the device in its initial position right after power has been turned on. Both **[[the]]** a reflector's cooling fan 712, and **[[the]]** a light pipe cooling mechanism 718 are on at this point. Sensors (not shown) provide feedback to the system to activate a pneumatic piston 743 to move **[[a]]** the drawer mechanism 742 along a base 721, out and away from the welding area. The drawer mechanism holds **[[a]]** the nest 714. The nest holds **[[the]]** components to be welded 709 and 710 (Figure 7b). Upon loading the nest with a work piece assembly (Figure 7b) containing both **[[a]]** the transparent **[[part]]** component 709 and **[[an]]** the absorptive **[[part]]** component 710, the operator pushes a momentary switch 744, to initiate the welding process. When a sensor (not shown) ascertains that the work piece is in the correct position, the pneumatic piston 743 returns the drawer 742 back to its position within the welding area. **[[A]]** The linear actuator 745, or a similar device that provides the same motion lifts **[[a]]** the holding nest 714, to the welding position (Figure 7d). This action is sensed by yet another sensor (not shown) which stops the cooling mechanism to the light pipe 718. In this position, the linear actuator 745 provides the required clamping force. As the shaped and masked end of the light pipe contacts the plastic assembly consisting of **[[a]]** the transparent component 709, and **[[a dark]]** the absorptive component 710 a proximity sensor or a mechanical switch (not shown) triggers a **[[the]]** radiant source 701 on. A timer (not

shown) provides the mean to control the time the plastic components are to be irradiated. [[A]] The fan 712, provides [[continuos]] continuous cooling 713 to a [[the]] reflector 702. A temperature probe 730 (not shown) attached to a temperature control (not shown) provides feedback to a programmable device (not shown). When the welding is complete, the linear actuator lowers the components (Figure 7f), which triggers the light pipe cooling mechanism 718 on. [[A]] The pneumatic piston 743 moves the drawer-like mechanism 742 out and away from the welding area. The operator removes [[the]] welded plastic components 751 from the holding nest 714, and inserts a new pair of components to be welded (Figure 7h). The cycle is repeated when the operator pushes the momentary switch 744.

On page 12, lines 1-10, please amend as follows:

Because of their simple nature, welding machines designed using the principles established in the invention are ideal for fully automated systems. An electronic control box provided with a touch panel (not shown), allows full programming of the step-wise welding process presented on Figure 8. A conveyor belt-driven system 800 in combination with miniature pneumatic pistons and sensors is utilized to move the components to be welded. Unwelded plastic components are assembled and then placed on holding nests 801. The conveyor moves the nests under a pre-heating system 802 for some pre-determined time, then under a photonic welder 803, [[were]] where bonding is performed. Bonded components exit the welder and then complete

the cycle by returning to the point of origin for loading and unloading of the components.

On page 13, lines 14-26, please amend as follows:

Figure 9 shows a photon welder **[[were]]** <u>where</u> a belt driven mechanism 901 such as the one described on Figure 8, moves a nest 902 carrying unwelded components 903. Air driven pistons 904, push the unwelded components against a short light pipe 905. A moment later, quartz halogen lamps 906 contained within elliptical reflectors 907 are turned on for some pre-determined time controlled by a fully programmable control station (not shown). The light is then trapped by long cylindrical light pipes 908 which direct the light towards short light pipes <u>905</u> that have been masked with aluminum or gold to conform the areas of the parts to be welded **[[905]]**. While the bonding takes place, a continuous stream of air cools both ends of the light pipes. The stream of air is provided by jets 909. Cooling for the reflectors and **[[the]]** <u>a</u> chamber 911 where the light pipes and reflectors are contained is provided by <u>the</u> various fans 910. Upon completion of the weld, the pneumatic pistons retract allowing the welded components to be carried away by the nest 902.